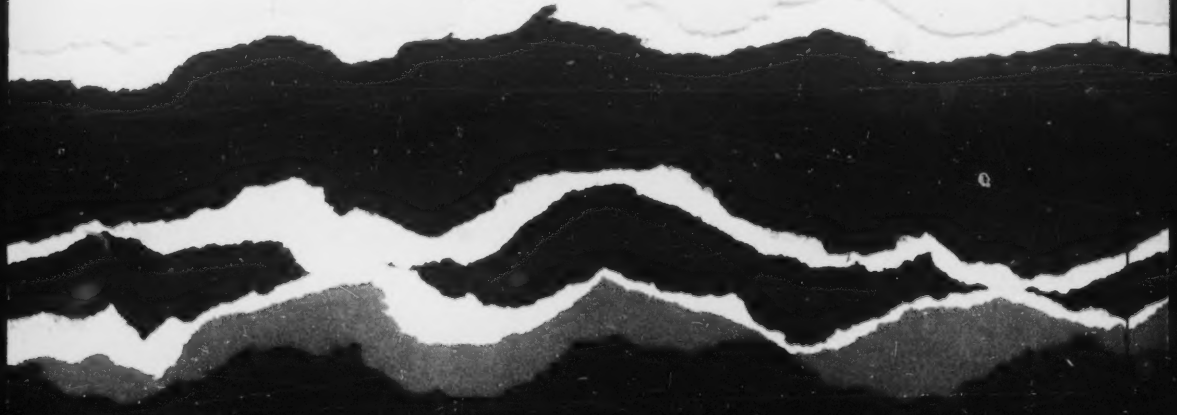
Wastes in Marine Environments



Summary

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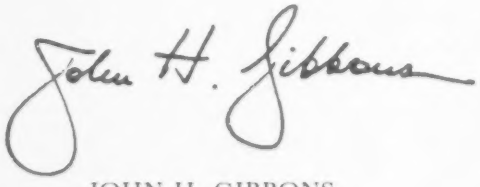
Foreword

"Where can we dispose of our wastes?" is a question being faced by virtually every community and industry in the country. For years, one common answer for communities and industries located in coastal areas has been to intentionally dispose of large amounts of waste materials in the Nation's marine environments—estuaries, coastal waters, and the open ocean.

Two congressional committees—the House Committees on Merchant Marine and Fisheries and on Public Works and Transportation—requested OTA to undertake a broad assessment of waste disposal in marine environments. In addition, the Senate Committee on Commerce, Science, and Transportation endorsed the assessment. As part of the assessment, OTA issued a report on *Ocean Incineration: Its Role in Managing Hazardous Waste* (August 1986), and a staff paper on *Subseabed Disposal of High-Level Radioactive Waste* (May 1986).

This final report addresses two fundamental questions: what is the general condition of different marine environments and their resources, and what role can and should marine environments play in overall waste management? OTA's principal findings are that estuaries and coastal waters are in deep trouble around the Nation, and that more coordinated waste management efforts are needed in many areas. As a Nation, we have been only partially successful in protecting these waters—and their ecologically, commercially, and esthetically valuable resources—from degradation. Policies to maintain or improve their quality, however, must be implemented in conjunction with policies about waste management strategies in general, including disposal in the open ocean and on land.

OTA is particularly grateful for the considerable effort devoted to this undertaking by our advisory panel, numerous contacts in Federal and State agencies, and numerous individuals in industry, academia, and public interest and environmental groups. These individuals helped OTA examine the enormous amount of available information from a number of important perspectives. We greatly appreciate this help.



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NOTE: OTA appreciates and is grateful for the valuable assistance and thoughtful critiques provided by the advisory panel members. The panel does not, however, necessarily approve, disapprove, or endorse this report. OTA assumes full responsibility for the report and the accuracy of its contents.

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Wastes in Marine Environments

OVERVIEW

The marine waters of the United States—estuaries, coastal waters, and the open ocean[1]—are used extensively for the disposal of various types of wastes. Much public concern and debate has focused on the form of disposal known as dumping, which occurs when wastes such as sewage sludge, industrial wastes, and dredged material are transported by ships or barges to designated marine sites and dropped overboard. Relatively less attention has been given to other marine disposal activities such as the discharge of industrial and municipal effluents from numerous pipelines and to nonpoint pollution from agricultural and urban runoff. Pipeline discharges and runoff, however, are at least as important as dumping in causing impacts on marine resources.[2]

OTA believes the most productive way to look at the disposal of wastes in the Nation's marine environments is to understand two fundamental issues: first, the general condition of each of the types of marine waters that are used for disposal; and second, the nature and extent of the role that these waters can and should play in waste management. This assessment's major findings about the first issue point to several policy options that could be instituted to maintain or improve the condition of these waters. The study also explores the policy implications of these options within the broad context of the second issue—the role of marine waters in waste management.

OTA developed three major findings concerning the health of the Nation's marine environments. Briefly they conclude the following:

- **Estuaries and coastal waters around the country receive the vast majority of pollutants introduced into marine environments. As a result, many of these waters have exhibited a variety of adverse impacts, and their overall health is declining or threatened.**
- **In the absence of additional measures, new or continued degradation will occur in many estuaries and some coastal waters around the country during the next few decades (even in some areas that exhibited improvements in the past).**
- **In contrast, the health of the open ocean generally appears to be better than that of estuaries and coastal waters.** Relatively few impacts from waste disposal in the open ocean have been documented, in part because relatively little waste disposal has taken place there and because wastes disposed of there usually are extensively dispersed and diluted. Uncertainty exists, however, about the ability to discern impacts in the open ocean.

[1]These terms are defined in box A.

[2]These terms are described in box B. OTA analyzed the ocean incineration of hazardous wastes in a companion report, *Ocean Incineration: Its Role in Managing Hazardous Waste* and the potential disposal of high-level radioactive waste under the seabed in a staff paper, *Subseabed Disposal of High-Level Radioactive Waste*. Box B lists other sources of pollution that are not covered in this assessment.

Box A.—Marine Environments and Relevant Federal Statutes

Types of Marine Environments*

Marine environments are classified in this study into three general categories: estuaries, coastal waters, and the open ocean.

Estuaries refer to semi-enclosed bodies of water that have some connection to the open ocean and an input of freshwater that mixes with saltwater. Most often estuaries exist at the lower reaches of rivers, but estuarine waters also can include lagoons and tidal marshes. Well-known examples include the Chesapeake Bay and the San Francisco Bay.

Coastal waters are generally less enclosed and more influenced by oceanic processes than are estuaries; they generally lie over the continental shelf, within the territorial sea.** Examples include the Southern California Bight and the New York Bight. The New York Bight extends beyond the territorial sea but is considered to be a coastal water because it is located on the inner portion of the continental shelf and is influenced by freshwater input from rivers.

The *open ocean* refers both to deep waters beyond the continental shelf and to waters over the outer continental shelf that are not measurably affected by freshwater input from rivers. The Deepwater Disposal Sites, which are used for the dumping of sewage sludge and some industrial wastes, are located on the continental shelf break in the open ocean.

Major Statutes Regulating Waste Disposal in Marine Environments

The Marine Protection, Research, and Sanctuaries Act (MPRSA) regulates the transportation and dumping of wastes in waters seaward of the baseline (inner boundary) of the territorial sea (see figure 1). The waters subject to MPRSA can be either open ocean (e.g., the Deepwater Disposal Sites) or coastal waters (e.g., the dumping site in the New York Bight); estuarine waters are excluded because they lie landward of the baseline.***

The Federal Water Pollution Control Act, known as the Clean Water Act (CWA), regulates all discharges into navigable waters of the United States, including the territorial sea (Sec. 502). Thus, CWA coverage generally extends to pipeline discharges and the dumping of waste from vessels in estuaries and some coastal waters. CWA also covers discharges from point sources other than vessels in waters beyond the territorial sea (e.g., in the New York Bight or the open ocean). CWA would thus apply to long outfalls from land-based facilities and to discharges from stationary drilling platforms, but not to the dumping of waste from vessels in waters beyond the territorial sea (the latter is regulated under MPRSA).

These two Acts overlap in their coverage of dumping from vessels within the territorial sea. Currently, such activity is restricted to dredged material disposal. In such cases, however, MPRSA preempts CWA (by the authority of MPRSA Sec. 106(a)). Thus, dumping that occurs in coastal waters or the open ocean is subject to the requirements of MPRSA; dumping in estuaries is subject to CWA.

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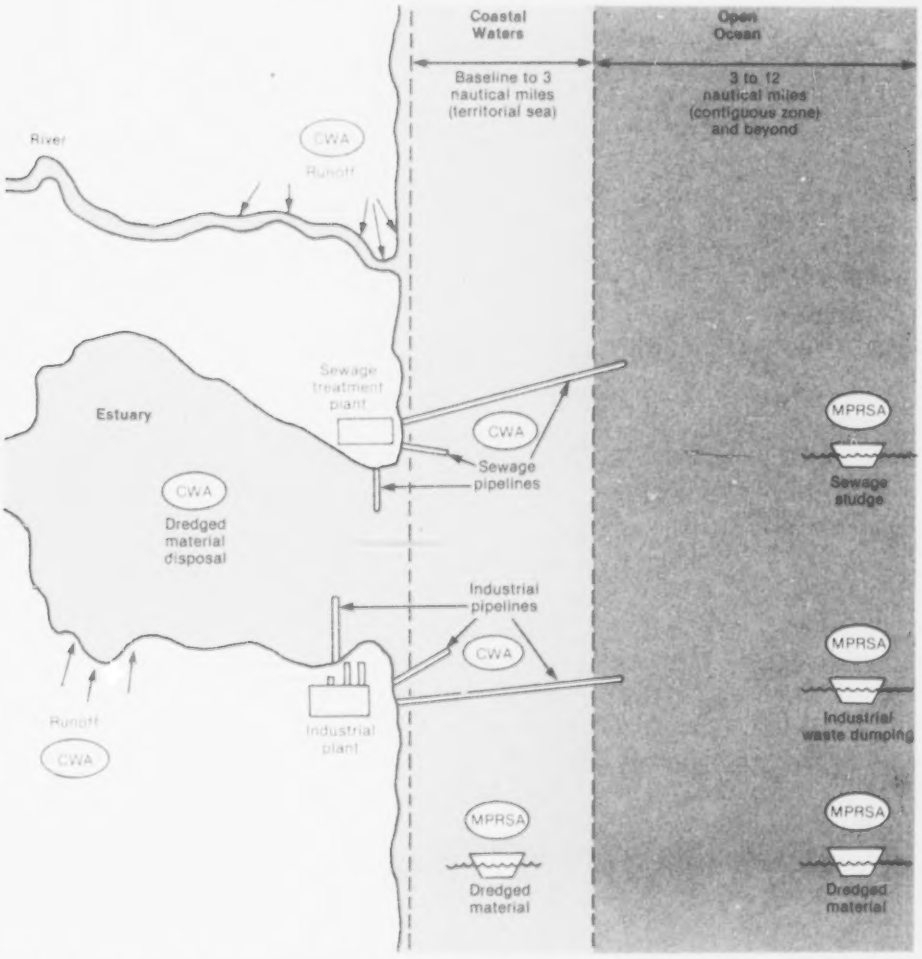
*This assessment excludes consideration of the Great Lakes and wetlands.

**The *territorial sea* extends seaward for 3 miles from what is called the baseline. The *baseline* is defined in Sec. 502(a) of the Clean Water Act as the "belt of the seas measured from the line of ordinary low water along that portion of the coast which is in direct contact with the open sea and the line marking the seaward limit of inland waters."

***For domestic vessels, MPRSA applies to dumping in all waters seaward of the baseline; for international vessels, it applies only to dumping in waters within the contiguous zone.

Figure 1.—Jurisdictional Boundaries of Environmental Laws Affecting Marine Disposal



CWA — Clean Water Act, formally known as the Federal Water Pollution Control Act.

MPRSA — Marine Protection, Research, and Sanctuaries Act.

Dumping beyond the inner boundary of the territorial sea is covered by MPRSA (CWA covers dumping within the territorial sea in principle, but is preempted by MPRSA (see box A)). Estuarine dumping falls under CWA.

Pipelines (wherever they are located) are covered by CWA.

SOURCE: Office of Technology Assessment, 1987; adapted from National Advisory Committee on Oceans and Atmosphere, *The Role of the Ocean in a Waste Management Strategy* (Washington, DC: U.S. Government Printing Office, 1981).

Managing Estuaries and Coastal Waters

Several Federal "pollutant control" programs have been established under the Clean Water Act (CWA) and the Marine Protection, Research, and Sanctuaries Act (MPRSA) to regulate the disposal (via both discharge and dumping) of wastes into marine waters and to control the levels of pollutants in these wastes.[3] The cornerstone of these programs has been the promulgation of *uniform* national regulations applicable to point sources of wastes or pollutants. Using this approach, some significant reductions in the quantities of pollutants entering marine waters have been and will probably continue to be achieved.

These programs represent reasonable approaches to address the problem of pollution in marine environments. However, while relatively easy to conceptualize, they have proven far more difficult to fully implement. Only partial implementation has been achieved to date and numerous obstacles hinder them from becoming fully operative. **Indeed, the prospect of ever achieving full implementation and enforcement is unlikely: the Nation's past commitment of resources has been insufficient to accomplish all the essential activities of existing programs (e.g., monitoring and enforcement) and even these resources are now declining.**

Moreover, even if total compliance with today's regulations is achieved, existing programs will not be sufficient to achieve some goals of the CWA, in particular to maintain or improve the health of all estuaries and coastal waters. In the absence of additional measures to protect our marine waters, the next few decades will witness new or continued degradation in many estuaries and coastal waters around the country (including some that exhibited past improvements):

- current programs do not adequately address toxic pollutants or nonpoint source pollution;
- pipeline discharges and nonpoint source pollution (particularly urban runoff) will increase as population and industrial development expand in coastal areas;
- Federal resources available for municipal sewage treatment are declining, and the ability of States or communities to fill the breach is highly uncertain; and
- in many cases, economic, technical, or social factors will make it difficult or impossible to shift disposal or dumping of certain wastes out of estuaries and coastal waters.

This projection of continued or increasing degradation is of great concern because estuaries and coastal waters are among the most important of all marine environments, with respect to their commercial resources, recreational uses, and ecological roles. Moreover, the ability to detect such deterioration and to understand its causes will be hampered if funding for monitoring and basic research continues to decline.

The nature and extent of impacts, and their causes, show tremendous variation from one estuary or coastal water to another. This diversity suggests

[3]These statutes are discussed in box A. The term pollutant is defined and types of pollutants are described in box B.

Box B.—Sources and Types of Pollutants Entering Marine Environments

Sources of Pollutants

The term *pollutant* is used in this assessment to refer to a substance or organism present in a waste, or to a property of a waste such as acidity, that *has the potential to affect* marine resources or humans. This definition is broader than that used by some observers, who limit the term to substances that are demonstrated to *have actually caused an adverse impact*. For consistency, and because of acknowledged limitations in the ability to detect impacts associated with marine waste disposal, the broader definition is used throughout this assessment. Although impacts associated with a pollutant are generally adverse, in certain settings the same pollutant may exert a beneficial impact, or cause an impact whose character is difficult to assess.

Pollutants can enter fresh or marine waters from intentional *waste disposal* (also known as point sources) or from what are called *nonpoint sources*. While this study is focused primarily on waste disposal, it places this in context with some major nonpoint sources that introduce pollutants into marine waters.*

Waste disposal encompasses a variety of discrete activities, including the *dumping* of sewage sludge, dredged material, and other wastes (e.g., acid-iron wastes, seafood processing wastes) and the *discharge* through pipelines of industrial and municipal effluents. Upon disposal, wastes can exert impacts as a consequence of two factors: the pollutants present in the waste, or the physical character of the waste itself (e.g., as in the burial of organisms by dredged material).

Major nonpoint sources of pollutants include runoff from land surfaces, underground transport through aquifers, and atmospheric deposition. Rural or nonurban runoff can occur on agricultural, range, mining, and forest lands. Urban runoff generally reaches waterbodies by flowing over surfaces such as streets, lawns, and construction sites.

The distinction between waste disposal and nonpoint sources becomes blurred, for example, when urban runoff (a nonpoint source) is channeled into "combined" sewers (which carry stormwater runoff and sewage) that subsequently discharge the material from pipelines.

Both waste disposal and nonpoint sources contribute pollutants directly to marine environments. They also can introduce pollutants into rivers that eventually flow into estuaries and coastal waters.

*This assessment does not consider sources of pollutants to marine waters that are distinct from land-based or land-originating sources. These include atmospheric inputs, discharges resulting from the operation of vessels (e.g., bilge waters), accidental releases (e.g., oil spills), and marine mining operations other than oil and gas drilling. In addition, wastes or pollutants such as plastics are considered only briefly.

Types of Pollutants

Pollutants are classified in the Clean Water Act into three groups**

1. *Conventional pollutants* (listed in Sec. 304(a)(4)) consist of:
   - total suspended solids (TSS; material remaining suspended in a waste after treatment);
   - biochemical oxygen demand (BOD; a measure of the amount of oxygen consumed during degradation of waste);
   - pH (a measure of the acidity of a waste);
   - fecal coliform bacteria; and
   - oil and grease (designated by EPA (40 CFR 401.16)).
2. *Toxic pollutants* (mandated under Sec. 307(a)(1) and listed in 40 CFR 401.15) include metals and organic chemicals.***
3. *Non-conventional pollutants* comprise a "catch-all" category that can include any additional substance that may require regulation. The current Federal list includes nutrients such as total nitrogen, nitrates, and total phosphorus and other substances such as chlorine, fluoride, and certain metals (40 CFR 122, app. D).****

Regulated Pollutants

In principle, any substance discharged or dumped into marine waters is subject to regulation as a pollutant under the CWA and the MPRSA; "catch-all" provisions in both statutes require that disposal of any material that would impede achievement of the broad goals of these statutes be regulated. To facilitate the development of regulations and to provide some consistency, specific lists of pollutants have been developed by the Federal Government. However, for a variety of reasons, standards that actually limit release have been developed for only a subset of these substances. Moreover, many additional pollutants that have been identified in wastes may be of concern with respect to environmental or human health; some State or local limits on such substances have been developed, but many remain entirely unregulated.

In practice, then, the term *regulated pollutant* has a rather limited meaning, referring only to: 1) those substances specifically included on government lists, or 2) the subset of these (plus any additional) substances for which limits are actually specified in discharge or dumping permits or ordinances. In this assessment, the term refers to a substance that meets one or both of these criteria, with the understanding that even for many regulated pollutants, actual limits governing their disposal have not been developed. The term *unregulated pollutants* is reserved for other potentially significant pollutants that do not meet either of these criteria.

**These classes are specified primarily for the purpose of developing effluent guidelines for pipeline discharges, but are generally useful in discussing pollutants present in other wastes as well.

***EPA currently lists a total of 126 toxic "priority" pollutants (40 CFR 122, app. D), an expansion of the initial list of 65. Other metals and organic chemicals, however, can also cause adverse impacts. OTA restricts the term *toxic* to the list of 126 substances and uses *metals or organic chemicals* more generally to refer to **any** metal or organic chemical.

****The statutory basis for regulation of substances other than conventional or toxic pollutants is provided by Sec. 301(b)(2)(F) of the Clean Water Act.

that any additional management efforts should be *site-specific*—i.e., tailored specifically to the needs and problems of individual waterbodies —regardless of whether such efforts are conducted by Federal, State, or local agencies. "Waterbody management" programs have been established for a few marine waterbodies (e.g., the Chesapeake Bay Program), but many other estuaries and coastal waters also need additional management.

If the Nation desires to maintain or improve the health of its estuaries and coastal waters, a two-tiered approach toward managing these waters will be needed. First, implementation of the present system of uniform national controls should be continued and enhanced to provide a consistent, minimum level of protection. Second, additional waterbody management that provides sufficient flexibility to address site-specific problems, while probably difficult to develop and implement, will be needed in many areas to supplement current programs. OTA's analysis of policy options for estuaries and coastal waters reflects this two-tiered approach.

Managing Open Ocean Waters

The health of the open ocean generally appears to be better than that of estuaries and coastal waters. Relatively few impacts from waste disposal have been observed, partly because the open ocean has been subject to relatively little waste disposal and because wastes are typically dispersed and diluted. Considerable uncertainty still exists, however, about the ability to discern impacts, particularly long-term ones, that may have occurred in the open ocean.

MPRSA has been relatively successful in managing dumping and providing some degree of protection for the open ocean. Nevertheless, the potential for harm to some valuable resources exists (e.g., from toxic chemicals such as polychlorinated biphenyls (PCBs), which have been detected in open-ocean fish).

Policy options for the open ocean discuss the implications of increasing, maintaining, or easing current restrictions on open ocean disposal. If wastes are disposed of in the open ocean, it seems prudent to ensure that they contain low levels of toxic pollutants. Few long-term adverse consequences would be expected if relatively uncontaminated sewage sludge and dredged material were to be dumped in the open ocean under dispersive conditions.

Viewing Marine Waste Disposal in Broad Context

The environmental legislation passed in the 1960s and 1970s and the continued popularity of the environmental movement are clear expressions of society's desire to protect the environment, including marine waters. The expected degradation in many estuaries and coastal waters and the relatively greater degree of protection afforded the open ocean, however, in some respects reflect a lack of *comprehensive* waste management. Current programs established to manage wastes focus primarily on one waste source or on disposal in one environment. Attempts to control one problem, however, sometimes generate other problems, and pollutants often have been merely transferred among environments or wastestreams without any significant overall reduction in associated risks.

Some problems might be alleviated if policy choices about the role of marine waters in waste disposal were made within the context of a hierarchy of preferred waste management strategies. These strategies include:

- reducing the generation of wastes;
- when possible, beneficially using or recycling wastes; and
- when beneficial uses are not possible, choosing treatment or disposal options that cause the least damage to the environment and human health and that are acceptable to society at large.[4]

None of these options eliminates risks entirely, and in some cases new risks can be created. **Moreover, not all waste generation can be eliminated.** Once wastes are generated, some type of "multi-media assessment" that compares the risks of different treatment and disposal options can help determine a preferred strategy in a given situation. Even then, a critical component will be public acceptability of the strategy itself and of the decisionmaking process.

To the extent that waste generation can be reduced, the need for disposal in different environments, including marine waters, can also be reduced. **It is evident, however, that large amounts of wastes requiring disposal (e.g., municipal effluents and sludge, industrial effluents, and dredged material) will continue to be produced, although the levels of specific pollutants in these wastes could be lowered.** At the same time, there is a strong desire for waste disposal to be inexpensive and to occur in remote locations. Several factors will increase pressure to use marine environments for waste disposal:

- the proximity of marine waters to major and/ or growing urban areas that generate large amounts of wastes requiring disposal;
- the frequently lower costs of marine disposal;
- limits on the economic feasibility of land-based disposal for some highly voluminous wastes (e.g., municipal effluents); and
- limits on the availability of land-based disposal options for some wastes (e.g., sewage sludge, dredged material, and some industrial wastes) because of increased public opposition and State or local regulatory restrictions.

Policy Choices for Marine Waste Disposal

As indicated by OTA's analysis, degradation of marine waters is most threatening in many estuaries and coastal waters. The open ocean, in contrast, exhibits relatively better health and has received a greater degree of protection. Thus, different policy choices are applicable to estuaries and coastal waters and to the open ocean.

Estuaries and Coastal Waters

With regard to impacts caused by waste disposal activities and runoff, the only policy choice available to maintain and improve the health of

[4]In this assessment, waste reduction includes those activities at the generating source that reduce the degree of **risk** associated with waste byproducts. Reduction and reuse options may be applicable to some extent to wastes commonly considered to be difficult to reduce or reuse. In some parts of the country, for example, municipal effluents are reclaimed for use in irrigation or groundwater recharge. Water conservation efforts could reduce the quantity of wastewater requiring disposal.

estuaries and coastal waters is to minimize pollutant inputs to these waters. One option to minimize inputs is to shift some disposal activities to the open ocean (depending on policies regarding open ocean disposal, discussed below), for example, by extending pipelines or moving the dumping of dredged material.[5] For a variety of technical, logistical, and economic reasons, however, it appears unlikely that a significant number of pipelines now located in estuaries and coastal waters could be extended much further offshore. Similarly, at least some dumping of dredged material in estuaries and coastal waters will be necessary. Some disposal activities might be moved to land, but the availability of some land-based options is becoming more restricted.

For these reasons, several other, more feasible options for minimizing waste disposal and pollutant inputs in estuaries and coastal waters deserve attention. These options are organized by OTA within a two-tiered approach:

1. **Maintain or consider expanding the current system of pollutant controls**, as exemplified by CWA's uniform technology-based controls and requirements. Ensuring maintenance would require some combination of continued Federal, State, and local investments in:
   —the construction of municipal treatment plants;
   —increased and sustained support for enforcement efforts; and
   —increased and sustained support for monitoring and research, to aid enforcement and evaluate long-term trends.
   Expanding the system would involve regulating more toxic pollutants, industrial sources, and pathogens.
2. **Establish additional, site-specific controls on waste disposal and nonpoint pollution where needed.**[6] This would require:
   —identifying those areas where such controls are needed;
   —establishing measurable, site-specific goals toward which progress could be evaluated; and
   —in some cases, initiating or expanding formal "waterbody" management plans such as those developed for the Chesapeake Bay and Puget Sound.

Both Congress and the Environmental Protection Agency (EPA) are well aware of the need to continue supporting existing efforts and to develop new initiatives like those listed above. Congressional awareness of these needs is reflected in some of the major provisions of the Water Quality Act of 1987, which amended the Clean Water Act (box C). EPA has been involved in developing several waterbody management programs (e.g., the Chesapeake Bay and National Estuary Programs) and has begun several efforts to identify waterbodies needing additional management. **Many of these initiatives to provide site-specific controls are in their infancy, however, and they will require much more direction, support, and oversight from Congress. Furthermore, these efforts currently are not part of a single, integrated strategy.**

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[5]Some shifting of sewage sludge dumping from coastal waters (at the 12-Mile Sewage Sludge Dump Site in the New York Bight) to the open ocean (at the Deepwater Municipal Sludge Site, 125 to 150 nautical miles southeast of New York harbor) is already underway.

[6]Although specific policy options for nonpoint pollution are not developed here, the relative importance of pollutants from disposal activities and nonpoint sources (particularly runoff) is evaluated.

Box C.—The Water Quality Act of 1987

The Water Quality Act of 1987 reauthorized and amended the Clean Water Act. Some major provisions pertinent to waste disposal and pollutants in the Nation's marine waters include:

- **Construction Grants Program and State Revolving Loan Funds:** Authorizes $18 billion through 1994 for construction of sewage treatment facilities. Construction grants program authorized at $9.6 billion through fiscal year 1990; from fiscal year 1989 to fiscal year 1994, $8.4 billion authorized for capitalization of State revolving funds, to be used for loans to local communities. Coastal States receive 55 percent of funds (for projects that affect fresh or marine waters). Some funds set aside for marine problems caused by combined sewer overflows and for National Estuary Program.
- **Ocean Dumping:** Bans sludge dumping in New York Bight Apex by December 15, 1987 (or date named by EPA, whichever first); prohibits dumpers other than those now using New York Bight Apex from dumping at Deepwater Municipal Sludge Site.
- **National Estuary Program:** Authorizes $60 million to address pollution in estuaries. EPA authorized to spend 10 percent on management conferences for individual estuaries and to provide $5 million annually to the National Oceanic and Atmospheric Administration for research. Priority given to 11 waterbodies.
- **Chesapeake Bay:** Authorizes $12 million for continuation of Chesapeake Bay Program and $40 million for grants to States.
- **Boston Harbor:** Authorizes $100 million for grants to improve municipal sewage facilities and water quality in Boston Harbor.
- **Control of Toxic Pollutants:** States must identify "hot spots"—waters not expected to meet water quality standards because of toxic pollutants in discharges, even after dischargers meet permit requirements. States must develop control strategies.
- **Sewage Sludge:** Requires EPA to identify toxic pollutants of concern in sewage sludge, and to establish numerical limits for each pollutant and management practices to achieve limits.
- **Nonpoint Source Pollution:** Authorizes $400 million for grants to help States reduce nonpoint pollution. States are to identify waters not expected to meet water quality standards and submit to EPA a management program for nonpoint pollution. Federal grants for up to 60 percent of costs of implementing State programs available to States with EPA-approved reports and programs.
- **Penalties:** Increases penalties for civil and criminal violations of clean water laws; gives EPA new authority to assess administrative civil penalties.
- **Compliance Deadlines:** Extends deadline for industrial compliance with national standards to within 3 years after EPA issues standards, but not later than March 31, 1989.
- **Anti-backsliding:** Prohibits relaxation of requirements when a discharge permit is renewed or rewritten, except in special cases.

Establishing additional, site-specific controls could be aided by increasing the emphasis given to the "water quality" approach. This approach consists of designating desired goals such as fishable waters for a waterbody, developing pollutant-specific numerical criteria that establish the quality of water needed to attain the goals, and implementing controls on wastes or pollutants from point and/or nonpoint sources to meet the criteria. The water quality approach, which has always been a component of CWA, was intended to supplement the uniform pollutant controls once they were well-established and thus provide an additional layer of controls when and where necessary. EPA has developed some water quality-based controls, but **in general the water quality approach has not been systematically applied to estuaries and coastal waters. Given OTA's findings about the declining health of many estuaries and coastal waters and the limitations on the effectiveness of pollutant control programs, it now seems appropriate that Congress and EPA begin developing a systematic framework to implement the water quality approach more extensively.**

Open Ocean Waters

Several distinct policy choices about the use of the open ocean for waste disposal are possible:

1. **maintain current restrictions on and allowances for open ocean disposal,**
2. **tighten these restrictions, or**
3. **ease them.**

Deciding which policy to choose depends on factors such as the availability of disposal options on land and in estuaries and coastal waters, as well as on the character of the particular waste in question. For example, *uncontaminated* sewage sludge and dredged material might best be used beneficially on land or in certain aquatic settings (e.g., sludge could be used to fertilize forestland; dredged material could be used to replenish beaches or wetlands). The feasibility of such uses can sometimes be limited, however, by economic constraints, land availability, public opposition, and local and State regulations. These wastes, as well as acid or alkaline industrial wastes, also can be dumped in the open ocean under certain conditions with little likelihood of causing significant long-term impacts.

Contaminated material, on the other hand, can rarely if ever be used beneficially and therefore generally requires some other form of management. In such cases, the full range of available options, including some forms of marine disposal, needs to be evaluated. For example, it might be determined that disposal of some types of contaminated dredged material is best accomplished by "capping" it with clean material in marine waters; in other cases, disposal on land may be preferable.

Pressure to use the open ocean for disposal of sewage sludge, dredged material, and some industrial wastes will probably increase, especially if greater protection is provided for estuaries and coastal waters.

In response to growing pressure for such disposal, Congress could choose to allow increased disposal of some wastes in the open ocean, deciding that some types of marine disposal are environmentally acceptable.

In contrast, Congress could opt to maintain or even strengthen the current restrictive policy, either because of concerns about the long-term health of the open ocean or because allowing such disposal could be a disincentive to developing better waste management options. This course of action might, however, interfere with attempts to implement other measures designed to improve the health of estuaries and coastal waters (e.g., shifting some dumping further out to sea). Therefore, maintaining or increasing the availability of alternative, land-based management options (e.g., waste reduction, treatment, and disposal) would be critical to the success of this strategy.

Whether or not increased disposal is allowed, Congress may wish to provide guidance and oversight by ensuring that:

- the level of pollutants in wastes is reduced prior to disposal;
- disposal sites and methods are chosen so that impacts are minimized;
- long-term monitoring and research is properly designed and coordinated; and
- disposal does not provide a disincentive to the development of beneficial uses for these wastes or to reduced waste generation wherever possible.

INFORMATION NEEDS

Many types of information are essential for developing policies about marine waste disposal, including information about the value of marine resources, ecological relationships, the quantity and fate of pollutant inputs from disposal activities, environmental and human impacts, and the ability of different disposal technologies to lessen impacts. Without such information, it is impossible to identify problems in specific areas, support enforcement activities, or effectively evaluate progress toward specific goals.

Programs for gathering and analyzing information are conducted by numerous Federal, State, and local agencies, as well as by industrial firms that must comply with regulatory requirements. The effectiveness of these programs has often been questioned. Some observers contend that: 1) monitoring is not sufficiently linked with basic research to facilitate the understanding of why certain impacts are occurring; and 2) too much responsibility for monitoring has been delegated from the Federal to the State and local levels, with a concomitant loss of proper design and quality control.

The responsible Federal agencies contend that the design, implementation, and success of such programs has improved in recent years. Agencies such as the National Oceanic and Atmospheric Administration (NOAA), EPA, and the Army Corps of Engineers (COE) have initiated many new programs during the 1980s that are better designed than their predecessors and that address issues on a more comprehensive basis. NOAA, for example, has several ongoing programs including an inventory of resources in the Nation's estuaries, a project to map living resources in the U.S. Exclusive Economic Zone, and a survey of outdoor marine recreation.

Nevertheless, information gaps still constrain analyses of marine waste disposal, partly because of a lack of information-gathering in some areas of the country, a lack of systematic analyses of gathered data, and ineffective dis-

semination of results. For example, high-quality, systematically analyzed information is not available about overall compliance with discharge permits, the types of pollutants present in many waterbodies, or the nature and extent of impacts in many waterbodies. Moreover, different programs that address the same issue often are not well-coordinated.

Many information programs also suffer from inadequate funding. Relatively little is invested in programs that obtain and analyze information in comparison with other expenditures (e.g., capital investments in pollution control technology). The effectiveness of pollution controls is difficult to evaluate without such information, yet funding levels for monitoring and other information programs generally are declining.

Increased political and financial support will be needed to ensure the coordination and proper design of these programs. Aside from actual information-gathering programs, continued support of basic ecological research and applied technological research also is needed, both to understand how waste disposal affects marine resources and to improve disposal methods.

POLLUTANT INPUTS AND IMPACTS IN MARINE WATERS

Waste Disposal and Pollutant Inputs

Estuaries and Coastal Waters

Many municipal and industrial wastes are *discharged directly* into estuaries and coastal waters. More than 1,300 major industrial facilities and 500 municipal sewage treatment plants discharge wastewater effluents directly into estuaries, and an additional 70 municipal plants and about 15 major industrial facilities discharge into coastal waters; only a few pipelines are used to discharge wastewater into the open ocean. Some sewage sludge is discharged through pipelines in southern California and in Boston, although these discharges are scheduled to be terminated.

The large quantities of waste entering estuaries and coastal waters through discharges reflect: 1) the close proximity of population centers and industries to these waters; 2) cost savings to waste generators that use this option; and 3) a management approach that allows certain discharges. The net effect is a considerable degree of "acceptance" of this routine but environmentally significant activity.

Dumping also occurs in estuaries and coastal waters. The majority (80 to 90 percent by volume) of all waste material dumped in marine waters originates from dredging operations. About 180 million wet metric tons of dredged material are dumped annually in marine waters.[7] According to COE, most of this material is relatively uncontaminated and does not contribute significant quantities of pollutants to these waters.[8]

[7]Almost two-thirds of the material is dumped in estuaries, about one-sixth in coastal waters within the territorial boundary, and one-sixth beyond the territorial boundary. Most dumping beyond the territorial boundary is still within coastal waters.

[8]Dredged material considered by COE to be heavily contaminated is disposed of, for example, in upland sites or by placing it in pits under water and covering it with uncontaminated material. Clearly defined, *quantitative* criteria are lacking, however, for deciding when dredged material is uncontaminated.

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The quantity of municipal sewage sludge dumped in marine waters has increased over the last decade and now totals about 7 million wet metric tons annually. Sludge dumping now occurs primarily in coastal waters at the 12-Mile Sewage Sludge Dump Site in the New York Bight, although it is scheduled to be shifted entirely to the Deepwater Municipal Sludge Site in open ocean waters during 1988.

Much smaller amounts (about 50,000 wet metric tons) of acid and alkaline industrial wastes are currently dumped in coastal waters each year at the Acid Waste Disposal Site in the New York Bight. Other wastes (e.g., seafood processing wastes or drilling fluids from offshore oil and gas operations) are also dumped or discharged into marine waters.

Relative Contribution of Pollutants From Waste Disposal and Nonpoint Sources.—The relative contribution of pollutants from discharges, dumping, and nonpoint sources varies with the type of pollutant and the location. In most estuaries and coastal waters, little or no dumping occurs and therefore discharges and runoff contribute greater amounts of pollutants. Where dumping does occur, however, it can sometimes be the major source of pollutants. The most extreme case probably occurs in the New York Bight, where dumping of sludge and dredged material accounts for one-half or more of the cadmium, chromium, copper, PCBs, total suspended solids, and phosphorus introduced to these waters.

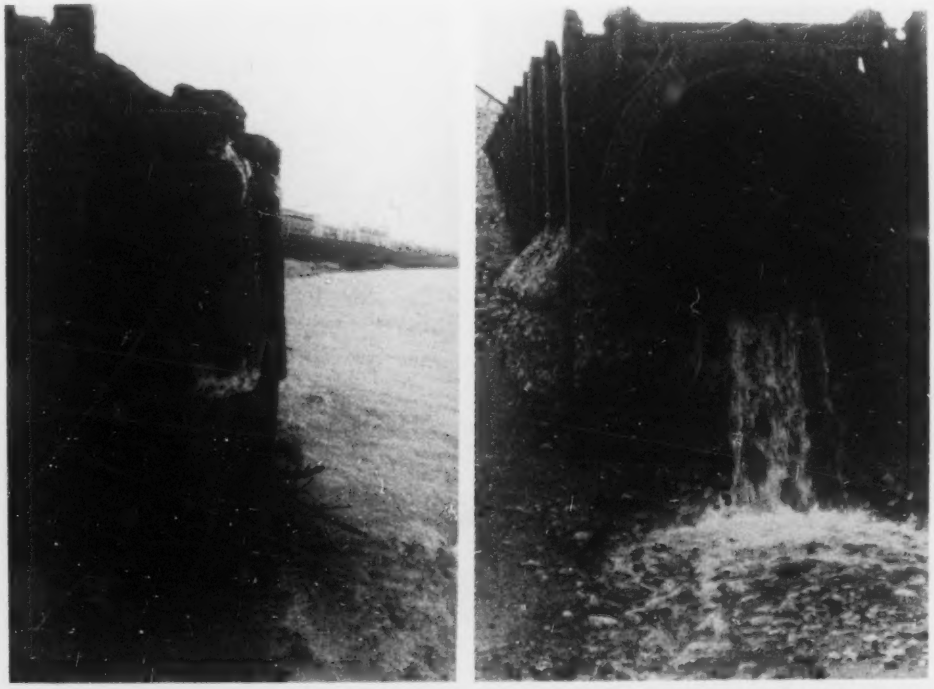


Photo credits: Courtesy of Greenpeace

Marine waste disposal activities (pipeline discharges and dumping operations) are overwhelmingly concentrated in estuaries and coastal waters. Over 1,300 major industrial and almost 600 municipal facilities discharge directly into estuaries and coastal waters, and at most a few discharge into the open ocean.

Metals and organic chemicals enter marine waters from various disposal activities, and they primarily originate from industrial discharges. A portion of the pollutants discharged by industries to municipal sewers passes through municipal treatment plants into receiving waters or contaminates sludge; thus, municipal plants can act as a conduit for industrial pollutants. Furthermore, the pollutants in industrial and municipal discharges can contaminate sediments that may later need to be dredged.

Pathogens enter marine waters through discharges of raw sewage (e.g., from septic systems or combined sewer overflows) as well as treated effluent and sludge. Municipal treatment processes destroy most, but not all, bacteria, and they are less effective against viruses and parasites.

Estuaries and coastal waters also receive large amounts of pollutants from upstream sources. Thousands of industrial and municipal plants discharge into rivers that subsequently flow into estuaries, and nonpoint runoff is a major contributor of pollutants to rivers. In some cases (e.g., the Mississippi River delta region), upstream sources are the major contributor of most pollutants; these pollutants may be highly diluted by the large flow of a river, however, so that their subsequent impact may be less than commensurate with their quantity.

Open Ocean Waters

In contrast with estuaries and coastal waters, relatively little dumping and discharge occurs in the open ocean. Some sewage sludge is now dumped at the Deepwater Municipal Sludge Site, and this site will eventually receive all of the sludge that is now dumped in the New York Bight as well as additional sludge from New York City's new treatment plants. About 30 million wet metric tons of dredged material (less than one-sixth of the material dredged from all estuaries and coastal waters) is dumped in the open ocean. Currently, about 150,000 metric tons of acid and alkaline wastes from two industrial facilities are dumped at the Deepwater Industrial Waste Site.

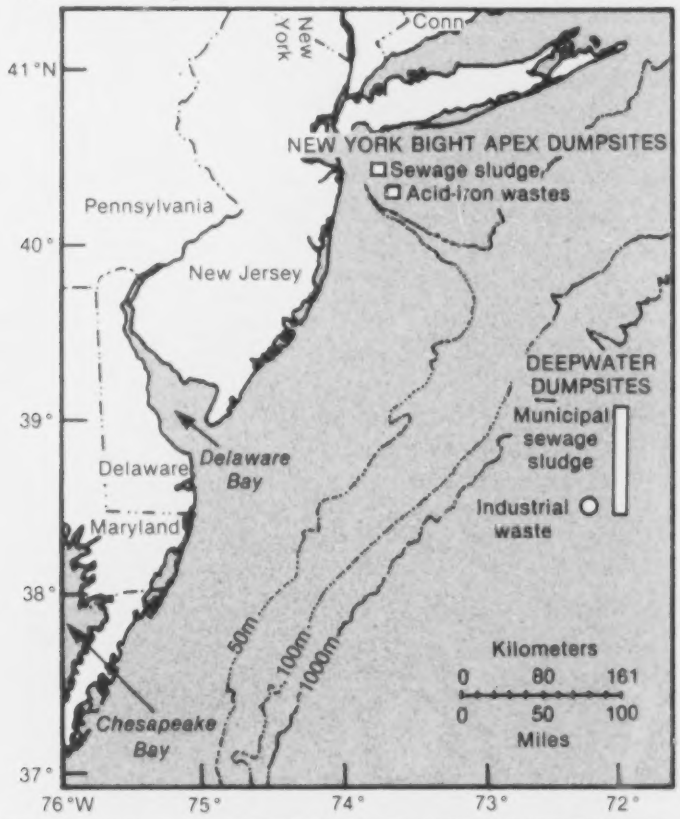
Over the past 10 to 15 years, industrial waste dumping has decreased dramatically, while dumping of sewage sludge has steadily increased; dumping of dredged material has fluctuated considerably during this period. Future pressure for dumping could take many forms. Some coastal municipalities (other than those already conducting such disposal) have expressed interest in renewing or initiating ocean dumping of sewage sludge if it were to be allowed, and certain large-volume, industrial wastes such as flue-gas desulfurization sludges and coal ash have been considered potential candidates for dumping.

Impacts on Marine Environments

General Nature of Impacts

Some conventional and nonconventional pollutants can contribute to excess nutrient levels (eutrophication) and low oxygen levels (hypoxia), particularly in estuaries and some coastal waters. Pathogenic organisms (e.g., certain bacteria, viruses, and parasites) contained in sewage or runoff can contaminate water and fish, resulting in direct risks to human health such

Figure 2.—Location of Current Municipal Sewage Sludge and Industrial Waste Dumpsites in the Northern Atlantic Ocean



SOURCES: 49 Federal Register 19005-19012, May 4, 1986; W.D. Muir, "History of Ocean Disposal in the Mid-Atlantic Bight," ch. 14 in *Wastes in the Ocean*, vol. 1, I.W. Duedall, et al. (eds.) (New York: John Wiley & Sons, 1983).

as outbreaks of hepatitis and gastroenteritis. Their presence can also cause direct economic and recreational losses.

Many metals and organic chemicals can cause severe, short-term, acute impacts on marine organisms. Moreover, many organic chemicals and some forms of certain metals can dissolve and accumulate in the fatty tissues of these organisms. When these organisms are consumed by predators, some of these pollutants can increase in concentration (i.e., biomagnify). Because of their persistence and toxicity, they can cause long-term, chronic impacts on organisms, potentially including humans. The presence of metals and organic chemicals in sewage sludge and dredged material also greatly constrains the management of these wastes.

Because of the sheer physical volume of waste that is dumped in marine environments—particularly dredged material—the solid material in such waste can modify bottom sediments or bury bottom-dwelling organisms at disposal sites. Such impacts, however, are often transient or reversible once the activity is halted.

Evaluating the Relationship Between Pollutants and Impacts

The nature and severity of impacts vary greatly among waterbodies, reflecting differences in the physical characteristics of the waterbodies, the extent and types of disposal that take place, and the types and values of the marine resources present. The information available to OTA supports the conclusion that, even though the precise link between specific pollutants and impacts is often unclear, **many of the adverse impacts on marine waters and organisms are caused by the introduction of pollutants through the disposal of wastes.** The site-specific relationship between impacts and waste disposal is illustrated, for example, through selected examples (see below). Evidence suggests that losses in individual incidents attributable to waste disposal (e.g., closures of shellfish beds or restrictions on fishing) can amount to millions of dollars; nationwide, many millions of people can be affected directly or indirectly each year.

Several factors create some uncertainty about the absolute extent to which pollutants from individual waste disposal activities contribute to observed affects, but not about the general conclusion that they do indeed cause many impacts. Uncertainty exists, for instance, because:

- pollutants can originate from many sources;
- the significance of contamination to marine organisms and humans is often poorly understood;
- impacts can be caused by other factors (e.g., overharvesting of fisheries or natural reductions in oxygen levels); and
- the information available is often incomplete.

For example, although good information exists about some areas, for many other areas little effort has been made to systematically collect and analyze needed data. This hinders attempts to rank estuaries and coastal waters according to their importance and extent of impacts, or even to confidently catalog all impacts that have occurred.

Health of Estuaries and Coastal Waters

Estuaries and coastal waters are among the most ecologically and economically important of all aquatic environments. Many such waters around the country have suffered significant impacts, although the overall trend during the last 10 to 15 years has been mixed. Some areas that once exhibited severe impacts have improved, but noticeable deterioration continues to occur or is accelerating in many other areas. Much public attention has focused on well-documented problems in the Northeastern United States (including the Chesapeake Bay and the New York Bight), southern California, and Puget Sound. Serious impacts, however, have also occurred in the less-studied Gulf of Mexico and the Southeastern United States.

The extent of degradation varies greatly around the country—in type, spatial scale, duration, and commercial importance. Observed effects include:

- impacts on water quality (eutrophication, hypoxia, turbidity, elevated concentrations of pollutants);
- loss of submerged aquatic vegetation;
- impacts on fish and shellfish (disease and abnormalities, reproductive failure, mortality);

- impacts on entire marine communities;
- closures of beaches and shellfish grounds because of microbial or chemical contamination;
- a rising incidence of reported human disease, from consuming contaminated shellfish or swimming in contaminated waters; and
- accumulation of toxic pollutants in sediments (in some cases, to levels that warrant classification as hazardous waste sites requiring cleanup under Superfund).

Estuaries and coastal waters are susceptible to these problems for several reasons. First, many marine organisms use these waters during critical parts of the organisms' life cycles (e.g., for spawning or nursery habitat). Second, these waters (particularly estuaries) bear the brunt of marine disposal activities and nonpoint pollution. Third, the physical and chemical features of many estuaries (circulation patterns, semi-enclosed configuration, shallow depth, mixing of fresh and saltwater) cause pollutants to be flushed relatively slowly from these waters or to actually become trapped.

Estuaries and coastal waters and their indigenous organisms can in some cases recover from certain impacts if the inputs of pollutants are reduced or terminated. For example, impacts on water quality such as low dissolved oxygen levels or eutrophication can be reversed, and areas where communities have been destroyed by physical burial can be recolonized. In many cases, improvements can result from better control of conventional pollutants and nutrients in municipal and industrial discharges or from halting the activity entirely. Other impacts, however, may require more time to be reversed or may in some cases be irreversible. For example, contamination of sediments with metals or persistent organic chemicals, or major changes in community structure (including ones caused by other, reversible impacts, such as loss of aquatic vegetation due to eutrophication) may be difficult, if not impossible, to correct.[9]

Health of Open Ocean Waters

Living resources in the open ocean also are commercially important, but they tend to be distributed unevenly (i.e., they can be concentrated in certain areas and relatively absent in others).[10] In general, the open ocean has exhibited few documented impacts that can be attributed to waste disposal activities, partly because fewer wastes have been disposed of directly in these waters. In addition, certain problems are less likely to occur there than in estuaries and coastal waters, because the physical character and processes of the open ocean (e.g., depth, currents, and wind) tend to dilute and disperse pollutants. For example, the open ocean is less susceptible to problems such as hypoxia or eutrophication, which generally occur only when certain conventional pollutants and nutrients are present in high concentrations, and to physical burial of organisms.

In contrast, metals, organic chemicals, and pathogens are of great concern, even though they also are dispersed, because: 1) they can cause im-

[9]Some areas also could continue to suffer impacts even if inputs of pollutants were halted.
[10]Many open ocean organisms also spend a portion of their life cycle in estuaries and coastal waters.

pacts at very low concentrations, 2) many are persistent, 3) some can accumulate in organisms, and 4) some can increase in concentration as they are passed up marine food chains. Uncertainty exists about the ability to discern impacts from these pollutants, because detection of such impacts is generally difficult and the impacts may not be observed until long after the polluting incident is over. Some of these pollutants have been detected in significant concentrations, both in the water and in the tissues of various marine organisms including fish, seabirds, and marine mammals. The significance of such contamination is not always clear, however, because of gaps in our understanding of issues such as the nature of open ocean food chains, the concentrations of various chemicals likely to cause reproductive failure in marine organisms, or the likelihood of pollutants being transferred to humans.

Selected Examples

Selected examples help to illustrate the relationship between waste disposal activities and other sources of pollutants and impacts on marine resources and environments. The examples presented here were chosen to represent a range of problems and geographic areas. They describe the value of resources in different marine waters, illustrate the great variation in the nature and severity of impacts among these waters, and mention management programs developed for some of these areas. The seven examples are:

1. Puget Sound,
2. San Francisco Bay,
3. the southern Louisiana coast,
4. Mississippi Sound,
5. Chesapeake Bay,
6. New York Bight and adjacent coastal waters, and
7. the Deepwater Disposal Sites in the open ocean.

Puget Sound

Puget Sound, a large and relatively deep waterbody in northwest Washington, contains numerous bays and inlets and is the receiving basin for many rivers. In contrast to other areas in the Northwestern United States, it is characterized by a high degree of urban and industrial development, dominated by Seattle. At the same time, however, numerous parks and wildlife refuges are scattered along its shores, and large adjacent areas are devoted to farming.

The Sound supports many commercially or ecologically important populations of fish and shellfish. The commercial and recreational harvest of fish and shellfish was valued at nearly $74 million in 1984. The Sound also is well-known for its diversity of birdlife and marine mammals—including harbor seals, gray whales, and killer whales. Its waters and shores annually attract 56 percent of the State's residents and support a large tourist industry.

The health of the Sound has become a major issue, in part stimulated by the designation of some areas as Superfund sites and by the publicity surrounding incidents like the unexplained death of eight gray whales in 1984. In general, problems in the Sound are most prevalent in embayments and inlets, which tend to trap and accumulate various pollutants. High concentrations of toxic metals and organic chemicals, for example, have made Commencement Bay one of the most contaminated sites in the country. Exposure of fish to toxic organic chemicals and metals has been linked to diseases and abnormalities—most notably, liver tumors in bottom-dwelling fish. As a result, many people are concerned that public health could be threatened by the consumption of contaminated fish. In addition, large parts of commercial shellfish beds have been closed because of fecal coliform bacteria contamination.

These impacts have arisen from past and current waste disposal practices and from nonpoint pollution. When conditions were worst, large volumes of untreated wastes were released, in some cases causing sediment contamination that still persists. Currently, over 400 municipal and industrial pipelines (both major and minor) discharge significant quantities of pollutants to the Sound. Runoff from agricultural and forest lands and urban surfaces is a major contributor of conventional pollutants.

Federal and State pollutant control programs have resulted in the reduction of some pollutants in municipal and industrial discharges. Further reductions are anticipated—e.g., Seattle is upgrading treatment levels at its municipal treatment plants. In an ambitious attempt to provide more coordinated management of all point and nonpoint sources, the State of Washington created and funded the Puget Sound Water Quality Authority in 1985. The Authority is developing a comprehensive plan for waste management in the Sound, and implementation of the plan will begin in 1987.

San Francisco Bay

San Francisco Bay actually is a large, shallow, enclosed estuary that receives water from rivers that drain California's Central Valley. Much of the Bay is ringed by intense urban development (including San Francisco, Oakland, and San Jose) and industrial development (including major petroleum refineries). Numerous parks and wildlife reserves, however, are located on the Bay's shores. Relatively little agricultural activity occurs directly adjacent to the Bay.

The Bay supports many valuable recreational and commercial fisheries, and serves as a magnet for a large tourist industry. It also serves many important ecological functions; for example, it provides important habitat for shorebirds as they migrate from Arctic breeding grounds.

A variety of activities—including filling of wetlands, discharges of municipal and industrial wastes, and diversion of freshwater inputs—have severely affected conditions in the Bay. At the turn of the cen-

tury, for example, industrial wastes were linked to the collapse of the Bay's oyster industry. Conditions continued to deteriorate for many decades, into the 1960s, when oxygen deficiencies periodically resulted in massive fish kills. The shellfish industry by that time had been largely destroyed.

In some respects, the situation has improved markedly since the early 1960s, primarily because pollutant inputs from municipal discharges were reduced by building improved treatment facilities. Fish kills no longer occur regularly, and concentrations of bacteria have declined. In 1982, shellfish harvesting was sanctioned in parts of the Bay for the first time since 1930.

The Bay still receives substantial amounts of pollutants, however, from industrial and municipal discharges and from the rivers draining the heavily cultivated Central Valley. As a result, serious problems persist, especially in the shallower and more poorly flushed portions of the Bay. Eutrophication and low dissolved oxygen levels occur frequently in localized areas. Organisms inhabiting the Bay have been exposed to elevated concentrations of pollutants—e.g., pathogens, metals, PCBs, and DDT—and many impacts to bottom-dwelling organisms, fish, and birds have been documented. Physiological abnormalities and population declines in striped bass, for example, have been linked with pollutants from waste disposal activities.

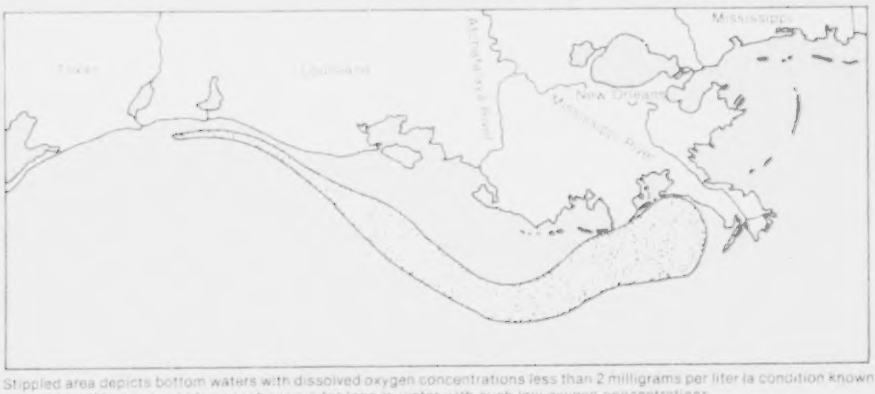
Various efforts to understand and mitigate the Bay's problems have been undertaken. Federal programs to control pipeline discharges are administered by the State's San Francisco Bay Regional Water Quality Control Board. The Aquatic Habitat Institute, a nonprofit organization formed in 1983, does not have a mandate to develop a comprehensive management plan, but is attempting to better integrate the efforts of parties involved with research on and management of pollution in the Bay.

The Southern Louisiana Coast

The coastal waters of southern Louisiana are dominated along their inner boundary by extensive marshes and then extend outward along the gently descending continental shelf. The Mississippi and Atchafalaya Rivers, which together drain over 40 percent of the continental United States, flow directly into these coastal waters.

These coastal waters are extremely productive and valuable, and large numbers of fish and shellfish spend all or portions of their lives there. These populations support a large fishing industry, centered on menhaden and shrimp. About 1.7 billion pounds of fish and shellfish, valued at nearly $230 million, were landed at Louisiana ports in 1985—far larger than the weight of the second largest amount landed (in Alaska). In terms of the weight of annual harvest, three of the Nation's top four fishing ports are located in southern Louisiana.

Figure 3.—Extent of Oxygen Depletion in Bottom Waters of the Louisiana Shelf, July 1985



Stippled area depicts bottom waters with dissolved oxygen concentrations less than 2 milligrams per liter (a condition known as hypoxia). Most animal life cannot survive for long in water with such low oxygen concentrations.

SOURCE: N. Rabalais and D.F. Boesch, *Extensive Depletion of Oxygen in Bottom Waters of the Louisiana Shelf During 1985* (draft manuscript, 1985).

This productivity is being undermined by extensive and periodic hypoxia (i.e., extremely low levels of dissolved oxygen in the water). The precise extent and duration of hypoxia change from year to year, but it is clear that large areas of the northern Gulf of Mexico have been affected. In the summer of 1985, hypoxia was evident in an area about four times larger than that seen recently in the Chesapeake Bay.

Few, if any, shrimp or bottom-dwelling fish are caught in such areas. In 1983, for example, the harvest of brown and white shrimp, as well as total fish biomass, declined along the Louisiana coast as levels of dissolved oxygen decreased. Hypoxic conditions during critical early periods of the shrimp life cycle also may have resulted in a more generalized decline in shrimp stocks.

The exact causes of the widespread hypoxia are not known. The waters of the Mississippi and Atchafalaya Rivers are laden with nutrients and conventional pollutants and appear to be contributors to the problem. At the same time, these nutrients are also one reason why these waters are so productive. The pollutants probably originate primarily upstream, from point source discharges and nonpoint runoff, but the relative importance of either source cannot be defined precisely.

While Federal and State pollutant control programs have reduced some municipal and industrial discharges, the hypoxia problem itself has not received major attention until recently. In 1985, the Louisiana Universities Marine Consortium initiated a research project on hypoxia in southern Louisiana, with an annual research budget of about $200,000, about half of which is provided by the Federal Government.

The Mississippi Sound

The Mississippi Sound is a long, shallow embayment stretching primarily along the southern end of Mississippi but also entering the coastal waters of Alabama and Louisiana. Its shoreward limits are characterized by marshes, bayous, rivers, and small bays; toward the more open coastal waters, it is bordered by a series of islands. The Sound is adjacent to several major urban and industrial centers, including Biloxi-Gulfport and Pascagoula-Moss Point. Among the area's industries are petroleum refineries, petrochemical plants, and pulp and paper plants.

The Sound is extremely productive and contains valuable nursery grounds for fisheries, as reflected by the area's large commercial fishing industry. Over 470 million pounds of fish—the fourth largest amount among all the States—were landed at Mississippi ports in 1985, with a value of over $40 million. Landings in the Pascagoula-Moss Point area, dominated by menhaden and shrimp, were among the largest for all Gulf of Mexico fishing ports. Recreational fishing in Mississippi has been valued at nearly $45 million, and coastal tourism generates an estimated $200 million each year.

A number of problems—eutrophication and hypoxia, and contamination by pathogens, metals, and organic chemicals—have been documented in localized areas of the Sound. For example, high concentrations of metals and organic chemicals occur in the Pascagoula River system and Biloxi Bay; the most troublesome of these pollutants are chlorinated hydrocarbons.

Significant quantities of pollutants have been entering the Sound for many years, from a variety of point and nonpoint sources. Metals and organic chemicals tend to concentrate in the sediments of rivers and bays near discharges or runoff sources, rather than in more open portions of the Sound. Because the area is undergoing continued rapid urban and industrial growth, marine resources in the area may be increasingly threatened.

At the State level, efforts to grapple with these problems are concentrated in the Bureau of Pollution Control and the Bureau of Marine Resources. The Gulf Coast Research Laboratory, an educational and research center founded in 1947, conducts research in the Sound; its funding is derived from the State and from grants and contracts.

Chesapeake Bay

The Chesapeake Bay—the Nation's largest estuarine waterbody—is located in Maryland and Virginia and is substantially sheltered from the forces of the open ocean. Numerous rivers flow into the Bay, draining parts of Maryland, Virginia, West Virginia, Pennsylvania, and Delaware. Its drainage includes extensive agricultural areas and several major cities; nearly 13 million people reside in the area.

The Bay is rich with marine life. Fish and shellfish are abundant and diverse, and many species use the Bay's waters as nursery areas. The Bay supports a fabled and valuable commercial fishing industry. The 1985 landings in Virginia and Maryland, most of which originated from the Chesapeake, totaled nearly 815 million pounds—about 13 percent of the total U.S. catch. These landings were worth nearly $124 million, over 5 percent of the total value of fish landed in U.S. ports. In addition, more than 1 million waterfowl—over 75 percent of the Atlantic flyway waterfowl population—winter in tidewater areas of the Bay. Submerged aquatic vegetation plays a pivotal ecological role for all of these organisms.

Several dramatic impacts have focused public attention on the Bay's overall health—in particular, declines in the striped bass population, contamination of the James River with the pesticide kepone, decreases in oxygen levels, and increases in eutrophication. Submerged aquatic vegetation has declined precipitously in recent years, in turn affecting valuable fisheries, bottom-dwelling organisms, and waterfowl populations. Numerous shellfish beds have been closed because of bacterial contamination. Contamination of sediments and organisms by metals and organic chemicals is severe in localized areas, in particular the Patapsco River near Baltimore and the James River and its tributaries.

Many of these problems—e.g., eutrophication and the decline in submerged aquatic vegetation —are caused by large inputs of nutrients and suspended solids into the Bay. Most of these pollutants originate from municipal sewage treatment plants and from agricultural runoff (both directly into the Bay and from upstream areas). Other pollutants such as metals and organic chemicals enter the Bay from industrial and municipal pipelines and from urban and agricultural runoff.

Because pollutants enter the Bay from many sources and States, coordinating efforts to deal with waste-related problems is complicated. Numerous local, State, and Federal agencies have jurisdiction over some aspect of the Bay and its resources. To address the complexity of problems and multiple responsibilities, Congress created the Chesapeake Bay Program. Coordinated by EPA, this program has pooled the energies of many local, State, and Federal agencies, as well as the general public and independent groups such as universities. To date, the program has evaluated the most important problems and potentially effective control mechanisms and has devised preliminary management plans.

The New York Bight and Adjacent Coastal Waters

The New York Bight is a large coastal waterbody located off the New York and New Jersey coastlines, adjacent to one of the world's largest urban and industrial concentrations. Its shorelines, bounded by Long Island and New Jersey, consist of open beaches or extensive bays and marshes protected by barrier islands. The Hudson River flows into Raritan Bay at its apex. The Bight extends seaward along the continental shelf to about 100 miles offshore.

The Bight contains important habitats, including crucial nursery and spawning areas, for various marine organisms. Shellfish and fish support sizable commercial and recreational fisheries. Birds migrating along the Atlantic flyway rely on the area as a stopover point or as wintering habitat. Recreational areas, including beaches and parks, and wildlife protection areas are scattered along the coastline.

The Bight receives large volumes of wastes from numerous sources, both directly and carried from upstream: industrial and municipal discharges; raw sewage; urban runoff; combined sewer overflows; some agricultural runoff; and dumping of sewage sludge, dredged material, industrial wastes, and construction debris. For example, several billion gallons of raw sewage, around 7 million wet metric tons of sewage sludge, and about 8 million wet metric tons of dredged material entered the Bight in 1985.

Pollutants from these sources have caused many problems, even though the Bight is large, relatively open, and more dispersive than enclosed waterbodies. Eutrophication and hypoxia have occurred in many areas. Pathogens, metals, and organic chemicals have contaminated sediments, the water column, and various organisms. These pollutants have been linked to diseases and population declines in marine organisms and to changes in community structure. High bacterial concentrations have resulted in widespread restrictions on shellfishing and permanent or temporary beach closures. High concentrations of PCBs have prompted restrictions on fishing and the sale of striped bass.

Public attention to these problems was galvanized in 1976, when reduced oxygen levels caused massive shellfish kills and when raw sewage washed ashore. These events were attributed by some of the public to sludge dumping, but other factors were equally or more important—natural events (seasonal water stratification), inputs of nutrients from other sources (including municipal discharges), and inputs of untreated sewage. Oxygen levels in 1985 were the lowest in some areas since the 1976 episode.

Determining the relative contribution of different sources to the Bight's problems has been difficult. Sludge dumping will soon be shifted out of the Bight to a site much further offshore, the Deepwater Municipal Sludge Site. The degree of improvement in water and resource quality in the Bight that will result from this shift is uncertain, however, given the magnitude of pollutant inputs from other sources. Improvements will only be detected if sufficient monitoring is conducted before and after the shift.

As might be expected, many Federal agencies (including EPA and the COE) and local and State agencies have some responsibility for different aspects of the Bight. Several public groups (e.g., the Coalition for the Bight and the New York Academy of Sciences) are bringing these agencies and the public together to discuss improving the quality of the Bight. Congress has considered amending MPRSA to establish a New York Bight Restoration Plan.

The Deepwater Disposal Sites

Two waste disposal sites are located in deep, open ocean waters above the continental slope, about 125 to 150 nautical miles southeast of the entrance to New York harbor—the Deepwater Municipal Sludge Site and the Deepwater Industrial Waste Site. Because the open ocean generally exhibits relatively low productivity, marine life at the sites is less abundant and of less commercial importance than in areas closer to shore or areas such as the Georges Bank. Nonetheless, some important species use the area as a migratory pathway, including commercial fish such as swordfish and tuna, endangered whales, and threatened sea turtles.

The two deepwater sites are located within the previously designated interim 106-Mile Ocean Waste Dump Site (or 106-Site). Dumping of various industrial wastes has occurred at the 106-Site since 1961. The amounts dumped peaked in the early 1970s at almost 5 million metric tons, and then declined to the present level of about 200,000 metric tons annually. Some very small quantities of sewage sludge also have been dumped at the site.

Monitoring has not detected any serious short-term impacts to marine resources, either at or near the 106-Site, associated with past dumping. This is not surprising, since the most easily detected impacts (e.g., eutrophication and hypoxia) are not likely to occur there for several reasons. First, the currents and depth of open ocean waters greatly disperse or dilute most of the dumped material. Second, industrial wastes tend to have relatively low concentrations of the pollutants (nutrients and suspended solids) which cause these impacts.

Although the 106-Site's health appears to be relatively good, the difficulty and expense of monitoring in these deep waters may preclude detection of long-term or cumulative impacts. Information about the nature and extent of impacts such as bioaccumulation of organic chemicals in migratory species, or persistence of difficult-to-detect pathogens, is currently scanty or uncertain.

The amount of industrial wastes dumped at the Deepwater Industrial Waste Site will probably remain stable during the next few years. The amount of municipal sewage sludge dumped at the Deepwater Municipal Sludge Site will increase substantially in the next few years; dumping of this material now takes place primarily in the New York Bight but is being shifted to the deepwater site. It is uncertain whether this increase will result in significant long-term impacts on marine resources; only a well-designed and supported monitoring program will be able to address this issue. In addition, some concern has been expressed about the ability of regulatory agencies to ensure that the wastes and disposal activities conform with legal requirements, since an expanded transport fleet will constantly be travelling to and from the deepwater site.

Three Federal agencies share responsibilities for the deepwater sites. EPA is responsible for reviewing and administering all ocean dumping permits, NOAA is involved with monitoring, and the Coast Guard is responsible for surveillance of dumpers and enforcement of maritime laws.

POLICY ISSUES AND OPTIONS FOR ESTUARIES AND COASTAL WATERS

Pressures to continue current disposal activities in estuaries and coastal waters will probably increase. Unless inputs of pollutants into estuaries and coastal waters are reduced, however, the extent and severity of impacts in these waters are likely to increase. The ideal strategy to protect most estuaries and coastal waters is to reduce waste generation or reuse wastes, thereby avoiding disposal. Even with extensive waste reduction efforts, however, large amounts of wastes now disposed of in marine waters will continue to require disposal for the foreseeable future.

Therefore, it will be essential to increase efforts to reduce the levels of pollutants in municipal and industrial discharges and to reduce nonpoint pollution where necessary, as well as to minimize waste disposal in estuaries and coastal waters wherever possible. The ability to minimize disposal in these waters, however, may be precluded by policy decisions made about disposal in the open ocean and on land. Reducing pollutant levels in discharges and reducing nonpoint pollution are likely to be more broadly applicable.

Any attempt to address impacts from disposal activities must therefore determine the ability of the current statutory and regulatory system to control pollutant inputs. Most Federal regulatory and management programs relevant to the control of discharges (as opposed to dumping) in estuaries and coastal waters fall under CWA.[11] Two basic types of regulatory programs have been established under the Act to address pollutant inputs into these waters: *pollutant control programs*, which regulate specific pollutants or sources; and *waterbody management programs*, which address the overall management of particular waterbodies.

The ability of these programs to achieve their stated goals is summarized below. Several options are described for improving the ability of pollutant control programs to reduce the inputs of pollutants and subsequent impacts. **For many waterbodies, however, improvements in pollutant control programs alone will not be sufficient. The policy question that must then be decided is whether additional efforts (and, if so, what types) should be undertaken to counter the onset, continuation, or increase in degradation in these waterbodies.** Options are presented below for providing additional waterbody management where necessary.

[11]Although CWA also addresses nonpoint pollution, the Federal Government has not been extensively involved in controlling this type of pollution. The Water Quality Act of 1987, however, authorized $400 million for grants to help States develop nonpoint management programs.

Issue 1: Current Pollutant Control Programs Will Not Protect All Estuaries and Coastal Waters

The two major pollutant control programs authorized by CWA are the National Pollutant Discharge Elimination System (NPDES) and the National Pretreatment program. These programs establish effluent guidelines and other requirements to regulate the discharge of certain pollutants from municipal and industrial facilities. States or EPA Regions have primary responsibility for granting permits and setting standards that incorporate these requirements, and discharges that meet the standards specified in the permits are legal.[12]

These pollutant control programs have been responsible for important reductions in some pollutants. The construction or upgrading of sewage treatment plants has reduced the levels of conventional pollutants and nutrients in many municipal discharges and, as a result, the health of some estuaries and coastal waters has improved in some aspects. In southern California coastal waters, for example, kelp beds have partially recovered. Similarly, reducing the levels of pollutants in industrial discharges into sewers has improved the quality of municipal sludge in some cases, allowing it to be used beneficially as fertilizer on farmland and forests.

[12]Some States also have developed plans for managing water quality that incorporate more stringent requirements (e.g., California).

Photo credit: Marine Resources Council, Melbourne, Florida

Estuaries and coastal waters are among the most ecologically and economically important of all aquatic environments. Humans use them for a variety of activities, including recreation, waste disposal, commercial fishing, and development. Some previously undeveloped estuaries and coastal waters are being urbanized, and the pollutants from subsequent waste disposal activities and urban runoff can greatly affect the resources in these waters.

Such reductions, however, have been achieved at considerable expense. The Federal Government has spent over $44 billion since 1972 to build municipal treatment plants that meet requirements specified in CWA and implemented through NPDES. Industrial facilities also have made substantial investments in response to the regulations established under these programs.

If compliance with existing regulations is achieved, the levels of regulated pollutants in municipal and industrial discharges are likely to continue to decline. The extent of future reductions, however, is difficult to predict. Although compliance has improved during the last few years, the likelihood of achieving full implementation and enforcement is unclear because Federal funding of some critical activities has been inadequate and is declining. For example, proposed funding levels in the fiscal year 1987 budget for water quality enforcement and permitting and for municipal enforcement are lower than current levels. As a result, some municipal and industrial facilities will probably continue to discharge pollutants in amounts that exceed their permit limits.

Moreover, even if total compliance with existing regulations were achieved, these programs would not be sufficient to maintain or improve the health of all estuaries and coastal waters in the future because:

- **Pipeline discharges and nonpoint source pollution (particularly urban runoff) will increase as populations and industrial development expand in coastal areas.**
- **Current pollutant control programs do not address all pollutants.** Standards have not been developed for some pollutants that are listed in CWA and present in wastestreams in large quantities because control technology is not available or because EPA has determined that its use would impose unreasonable economic burdens on affected industries. Standards also have not been developed for other pollutants that can be important in some situations but that are not listed in CWA (e.g., organic chemicals such as dibenzofurans and trichlorophenols; pathogens such as viruses).
- **Current pollutant control programs do not address all sources of pollution.** These programs already address the most easily controlled sources, in particular municipal and most industrial discharges, but they do not adequately regulate some additional important industrial sources of pollutants (e.g., textile mills and commercial laundries) or nonpoint sources.
- **Federal resources available for maintaining or improving current levels of municipal sewage treatment are declining, and the ability of States or communities to fill the breach is uncertain.**[13]
- **Monitoring, research, and enforcement currently are inadequate, and funding levels for these activities are being reduced in some instances.**
- **The contamination of sediments with persistent toxic pollutants is not adequately addressed.** These sediments may be a source of con-

[13]In 1984, EPA estimated that about $110 billion would be required by the year 2000 for the Nation to meet its remaining municipal treatment needs; the Federal share would have been about $36 billion. EPA recently lowered its estimate of remaining municipal treatment needs to $76 billion by the year 2005. The Water Quality Act provided $18 billion for the Construction Grants Program and State revolving loan funds, with funding ending in 1994.

Photo credit: Southern California Coastal Water Research Project Authority

Beds of giant kelp along the southern California coast provide important habitat for many valuable fish and shellfish and support a substantial kelp harvesting industry. Large acreages of these beds disappeared prior to the 1970s, in part because of pollutants discharged to nearby waters. Reductions in the discharges of some pollutants, accompanied by kelp restoration efforts, have helped reverse this trend and kelp bed acreage is now increasing.

tamination for long periods; many observers have proposed the need to develop sediment quality criteria analogous to those for water quality.

Options To Improve Current Pollutant Control Programs

Although total implementation of and compliance with existing pollutant control programs will not be sufficient to maintain or improve the health of all estuaries and coastal waters, these programs will continue to achieve important reductions in pollutant inputs and to provide the primary foundation for pollution control efforts. Therefore, maintaining and improving their capabilities is critical. Four sets of options for improving these capabilities are discussed below:

1. improving enforcement;
2. ensuring adequate funding by Federal, State, and/or local sectors of municipal treatment plant construction;
3. regulating "important" or additional pollutants and industrial sources; and
4. applying ocean discharge criteria to estuaries and coastal waters.

Option 1: Improving Enforcement

Enforcement of current regulations on point source dischargers is inadequate for many reasons. More rigorous enforcement would reduce pollutant discharges by the affected parties and would provide a greater deterrent to other facilities. Mechanisms for improving enforcement include the following:

- **Support continued or enhanced implementation and enforcement of the current NPDES and pretreatment programs, through oversight, financial support, and technical guidance.**
- **Enhance EPA's enforcement authority by allowing administrative civil penalties in addition to court-imposed civil penalties.**[14] Congress also could consider the effectiveness of the provisions that encourage enforcement actions by private citizens.
- **Provide oversight to ensure that efforts to focus or target enforcement activities are based on consistently applied criteria.** EPA, for example, has implemented a policy to focus enforcement efforts first on major dischargers in "significant" noncompliance, then on major dischargers in less significant noncompliance and on minor dischargers.

Option 2: Ensuring Funding of Municipal Treatment Plant Construction

Under the provisions of the 1987 Water Quality Act, only $18 billion in Federal funds will be provided for municipal treatment needs. EPA intends to continue requiring municipal treatment plants to comply with CWA's treatment requirements, however, whether or not Federal funding is available to help meet these requirements. A long-term capacity, therefore, still must be developed for funding new plant construction, replacing or repairing treatment plants as they deteriorate, and expanding capacity as needed. The large-scale feasibility of different non-Federal funding mechanisms such as State revolving loan funds, privatization, nondebt financing, and municipal bonds has been debated but remains uncertain.

[14]In the Water Quality Act, Congress granted EPA new authority to assess administrative civil penalties.

Congress considered this problem and authorized: 1) a transition period until 1994 to allow States and localities to develop alternative funding mechanisms, and 2) about $8 billion (of the total authorization of $18 billion) to be used for the capitalization of State revolving funds. Congress could further support efforts to develop funding mechanisms, for example, by increasing direct incentives for their development; such incentives could include tax credits for privatization.

Option 3: Expanding Regulation of Important Pollutants and Sources

The coverage of the pretreatment and NPDES programs could be expanded by developing standards for additional individual pollutants and sources of pollutants, particularly industrial sources. The mechanisms to expand coverage generally are already available to EPA, but Congress could provide support for expansion initiatives through oversight and commitment of sufficient financial resources. This could entail several complementary approaches:

- **Promoting the development of effluent guidelines for pollutants that are listed in the Clean Water Act as priority pollutants but for which guidelines have never been developed.**
- **Supporting efforts to identify pollutants not on the CWA list but that can cause significant impacts, and supporting efforts under the pretreatment and NPDES programs to develop effluent guidelines for these pollutants.** EPA, for example, has undertaken preliminary efforts to develop screening processes and tests to identify additional pollutants that are important in marine waters, but no new effluent guidelines have yet been developed. Such efforts will require more research on the potential impacts of unregulated pollutants, and monitoring to search for specified pollutants in individual waterbodies.
- **Expanding pollutant control programs to improve coverage of important point sources that are not adequately regulated.** These include certain unregulated industrial categories (e.g., commercial laundries) and combined sewer overflows or stormwater outfalls.
- **Supporting EPA's ongoing effort to develop technical guidance on the quantities of toxic pollutants allowable for different municipal sludge disposal options.**
- **Deciding how to best address the problem of hazardous waste discharges into municipal sewers.** An exemption in the Resource Conservation and Recovery Act (RCRA) that allows such discharges could be abolished. If it is, problems in other environments could ensue (e.g., because of illegal dumping). If the exemption is retained, then improving the implementation and enforcement of the pretreatment program would become critical in ensuring adequate regulation and treatment of such discharges. This could include expansion of efforts by municipal treatment plants to develop local limits on such discharges.[15]

[15]This problem is symptomatic of a larger issue, the role of municipal plants in the management of industrial wastes. Municipal wastes are often contaminated to some degree with metals and organic chemicals from industrial discharges, and some observers have suggested prohibiting industrial discharges into sewers. The near-term likelihood of a prohibition is low, although the practice could be partially restricted by prohibiting new industrial discharges into sewers. Water quality would then depend on the control (by NPDES) of direct industrial discharges and/or the implementation of other management options such as waste reduction, process substitution, recycling, and centralized treatment facilities.

Option 4: Applying Ocean Discharge Criteria to Estuaries

The CWA Ocean Discharge Criteria (Sec. 403(c)) currently apply to discharges into coastal waters, but not to discharges into marine waters inside the baseline of the territorial sea (i.e., estuaries). These criteria specify additional factors that must be considered prior to the granting of a permit for discharging into non-estuarine marine waters, and in theory provide greater regulatory control.

Congress could consider applying the Ocean Discharge Criteria to discharges into estuaries, which would provide an additional means of control on such discharges. Whether this would increase actual protection would depend on the strength of the criteria. If necessary, the criteria could be strengthened by making the issuance of a discharge permit contingent on additional factors, such as:

- development of an acceptable monitoring protocol;
- specification and acceptance of conditions under which the discharge may be terminated or modified (e.g., if monitoring revealed severe impacts); and
- requiring that a need be demonstrated to discharge wastewater into estuarine waters.[16]

Issue 2: Some Estuaries and Coastal Waters Need More Comprehensive Management

More comprehensive planning and coordination of management efforts will be needed for several reasons if the Nation wishes to lessen, avoid, or reverse degradation of some estuaries and coastal waters. First, estuaries and coastal waters exhibit very *site-specific* characteristics with respect to physical nature, disposal activities and impacts, and economic importance. Second, these waters can encompass multiple political jurisdictions and fall under the authority of multiple agencies.

Third, the need to allocate available resources efficiently will become more critical, because financial resources for Federal and State pollution control efforts probably will not increase substantially in the future. In addition, because pollutants can be contributed by many sources, it is not always clear whether changes in current pollutant control efforts, such as regulating additional pollutants or achieving full compliance, would be sufficient to achieve the desired improvements, or whether new efforts are needed. Increasing the effectiveness of point source control programs might be sufficient in some areas, whereas in other areas efforts to control nonpoint source pollution may be critical.

These factors necessitate greater coordination and cooperation among responsible agencies to identify site-specific problems and allocate resources toward the most effective control efforts.

The need for comprehensive and coordinated management has led to the development of some "waterbody management" plans and programs by the

[16]The first two of these additional criteria are currently not included among the Ocean Dumping Criteria either.

Federal Government (e.g., Chesapeake Bay Program), the States (e.g., Puget Sound Water Quality Authority), and local authorities (e.g., Southern California Coastal Water Research Project). In most cases, numerous agencies from different levels of government share responsibilities for implementation.

Existing waterbody management programs vary greatly in their design. Some have the authority to set goals and establish plans, while others are designed only to gather and share information about research needs or findings. Most programs have the authority to perform only some of the following functions: address multiple disposal activities and pollutant sources, identify the most serious or tractable problems, allocate resources toward these problems, design and implement management plans, and coordinate various involved agencies.

In general, existing waterbody management programs are in the early stages of implementation and their effectiveness cannot yet be judged. While these efforts appear promising, programs have been established for only a few waterbodies to date; many of the estuaries and coastal waters in need of additional management are not covered by such programs. Furthermore, current programs generally have only limited authority and financial support, and may not be sufficient to ensure the health of the target waterbodies.

Options To Provide Additional Waterbody Management

Creating new waterbody management programs would probably be relatively straightforward, and in the Water Quality Act of 1987 Congress designated some specific waterbodies for which management efforts should be undertaken. **However, establishing a systematic approach for providing comprehensive and coordinated waterbody management will require additional, difficult policy decisions. The critical link that is lacking is a framework for making decisions about when and how to provide additional means of management, in particular, how to complement the current uniform national pollutant control programs to address situations that require additional, site-specific controls.**

A water quality-based approach could complement the system of primarily uniform, technology-based controls and provide a framework for addressing the site-specific needs of individual waterbodies.[17] Although the 1972 CWA Amendments marked a shift away from this approach and toward the use of technology-based standards, the authority to institute water quality-based regulation was retained in the Act because Congress intended it to serve as an additional layer of pollution control, after the more uniform pollutant control programs were well-established. In general, however, it has not yet been used to provide comprehensive and coordinated management

[17]A water quality-based approach places controls on pollution sources, based on an assessment of the concentrations of pollutants in receiving waters below which unacceptable impacts will not occur. It relies on the development of water quality-based standards, which consist of designated uses (e.g., swimmable water) for defined segments of waterbodies and pollutant-specific numerical criteria designed to assure attainment of the uses. The States designate uses and set water quality standards, with Federal guidance. Individual dischargers generally have greater flexibility in choosing how they will comply with water quality standards than with technology-based standards. A water quality approach, however, requires enormous amounts of information, continuous monitoring, and the development of site-specific criteria for many pollutants. Nevertheless, developing such an approach could provide the flexibility to address site-specific problems.

of estuaries and coastal waters,[18] although EPA has begun to develop a water quality approach to better control toxic pollutants in discharges.

Development of a framework that uses a water quality approach to provide additional waterbody management, where needed, now seems appropriate. Such a framework, which could build on existing mechanisms, would differ from or expand on current efforts by:

- **providing better means of evaluating progress in improving the quality of estuaries and coastal waters;**
- **identifying those waterbodies that will continue to be degraded, even after continued development and implementation of current pollutant control programs;**
- **developing new waterbody management programs for some of these waterbodies; and**
- **providing the guidance and flexibility needed for waterbody management programs to set site-specific goals and establish coordinated plans for achieving those goals.**[19]

Implementing these steps could take considerable time. In addition, the relative roles of Federal, State, and local governments in these activities is a central issue. Some observers advocate reliance mostly on State and local efforts, while others advocate a strong Federal role. This issue is addressed briefly below, but in general the question of primary responsibility will need to be addressed on a case-by-case basis.

Option 1: Establishing Measurable Goals and Evaluating Progress

CWA established as national goals the elimination of discharges of toxic pollutants in toxic amounts and the restoration or maintenance of fishable and swimmable waters. Clearly, such improvements will not, and were not expected to, occur overnight; many years may pass before the effects of changes in pollutant control programs or of now-developing waterbody management programs become apparent.

Moreover, it is often difficult to measure progress toward such broadly stated goals. Establishing goals toward which progress could more easily be measured could increase the ability to assess improvements in the health of estuaries and coastal waters, and, concomitantly, increase the ability to judge the need for additional controls. Congress might consider:

- **Refining the goals of CWA so that they apply explicitly to estuaries and coastal waters.** This could involve a statement of the intent to maintain the current quality of resources or to reverse any trends of degradation in these waters.

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[18]For example, 9 of the 24 coastal States have not developed marine water quality standards for any priority pollutants. For the 8 coastal States that have marine standards for priority metals, standards have been developed for an average of 4.5 of the 14 metals. For the 15 coastal States that have such standards for priority organic chemicals, standards have been developed for an average of 6.8 of the 85 organic chemicals.

[19]Some of the decisions that would be made within such a framework would be affected by the availability of land-based and open ocean disposal options. For example, if the relatively restrictive policy regarding waste disposal in the open ocean is maintained, then some methods for improving the quality of estuaries and coastal waters, such as shifting disposal further out to sea, will not be available.

- **Supporting the further development and implementation of the water quality approach and the specification of site-specific, measurable goals toward which progress could be measured.** To be effective, such goals should be quantitative whenever possible and should be directly linked to tangible improvements in resources. Examples of measurable goals include:
  —avoiding specific impacts (e.g., no fish mortality in a specified area);
  —achieving desired changes in ecological conditions (e.g., reestablishment of submerged aquatic vegetation in a specified area); and
  —achieving desired changes in economic or recreational returns (e.g., the lifting of restrictions on harvesting shellfish).

Pollutant control programs would still need to be implemented and enforced, but they would only constitute a first step. Measurable, site-specific water quality goals would allow the effectiveness of these programs to be evaluated. If the waterbody met the goals, then no additional control efforts would be needed. If it did not meet one or more goals, then available resources could be focused on the most viable or most cost-effective control efforts; additional permit limits on discharges, as well as the use of best management practices for controlling nonpoint pollution, could be required in site-specific situations.

Two additional uses of the water quality approach to waterbody management deserve mention:

1. A water quality approach could be extended to address sediment quality. Sediment quality criteria could be useful in determining, for example, if shellfish harvesting in a particular area should be restricted, or whether dredged material is sufficiently contaminated to pose undue risks to bottom-dwelling marine organisms. These criteria do not currently exist.
2. A water quality approach could be extended to account for pollutants that enter an estuary from upstream sources.

Some observers have argued that supplementing current technology-based controls with even stricter controls in response to water quality standards might impose unreasonable financial burdens on dischargers. Congress may wish to consider the use of financial incentives such as fees or taxes to ease this burden. According to some economists, this market-oriented approach to water quality management could be introduced in a manner that does not unduly compromise the technology-based approach.

Option 2: Identifying Waterbodies Needing Additional Management

Not all estuaries and coastal waters require additional management, so some mechanism would be needed to identify waterbodies likely to suffer degradation despite current pollution control efforts. **This need probably could be met by establishing a "screening" process to identify those waterbodies requiring additional management.**

Some States have developed criteria to identify such waterbodies, but uniform criteria probably should be used since waterbodies around the Nation are involved. Consistent criteria could be developed, for example, by the Federal Government and used by States to evaluate waterbodies within their

boundaries. Some waterbodies, however, are bounded by and receive pollutants from several States, and multiple agencies could have responsibilities pertinent to waterbody management. In such cases, it may be appropriate to have the Federal Government conduct or coordinate the process. EPA and NOAA are evaluating such an approach for some coastal waters, so a new program would not necessarily be required.

Photo credit: Tim McCabe/Soil Conservation Service

Agricultural runoff can carry soil particles, pesticides, bacteria, and other pollutants directly into estuaries and coastal waters or into rivers that flow into these waters.

A screening process would need to precede other management decisions and thus should be relatively streamlined. Information would need to be collected for most or all of the Nation's estuaries and coastal waters, so decisions regarding what information will be needed should be made early in the process.

Option 3: Developing Management Plans

If a general goal of maintaining or improving the health of estuaries and coastal waters is to be pursued, additional programs will need to be developed for those waterbodies likely to suffer continued or new degradation. Several options exist for overseeing the development of management plans and defining the structure of individual waterbody management plans:

- **Decide whether a national program is necessary to coordinate and oversee the development of individual management plans.** While a strong Federal presence has not been necessary for the initiation of some programs (e.g., in Puget Sound), a national program could: 1) conduct any screening effort, 2) encourage States to develop plans for waterbodies entirely within their jurisdiction, and 3) initiate the development of programs for waterbodies encompassing multiple jurisdictions. A program could be newly developed or could build on ongoing efforts such as the National Estuary Program. If needed, a Federal program could provide incentives to the States, for example, by making grants contingent on the development of adequate plans.
- **Establish national guidelines for the development of individual plans.** Individual plans could be required to: 1) designate a lead agency to coordinate planning, 2) establish site-specific, measurable goals, 3) specify what efforts would be undertaken to achieve the goals, and 4) indicate how progress will be evaluated and reported.[20] The requirement to define specific goals and evaluate progress could be structured in a manner analogous to State Implementation Plans under the Clean Air Act. Under this Act, planning agencies must determine whether air masses are in attainment with standards and establish plans describing how attainment will be achieved in nonattainment areas. For waterbody management plans, responsible planning agencies could be required to undertake similar planning.
- **Support the development of well-designed, long-term monitoring and data analysis programs whose results can be used to evaluate progress toward specific goals.** Such programs would have to be long-term because attainment of some goals is likely to require relatively long periods. If a monitoring or analytical program indicated insufficient progress toward attainment, then responsible agencies might need to shift planning or control efforts. Any planning and evaluation processes thus would have to be continuous and include mechanisms for modifying plans as needed.

Proposals to expand existing waterbody management programs or to develop new ones with multiple responsibilities might be dismissed for fear of

[20]The Coastal Zone Management Act provides another possible vehicle for such plans, but it has generally focused more on development and land-use issues than on waste disposal activities. Some coordination of any waterbody management plan with State Coastal Zone Management plans, however, would still be essential.

large new expenditures. It is true that efforts to maintain or improve the health of estuaries and coastal waters will require new expenditures. If, however, management programs can identify site-specific problems and coordinate control efforts, the overall costs of such efforts could in some cases be less than the costs of separate, uncoordinated pollution control efforts.

POLICY ISSUES AND OPTIONS FOR OPEN OCEAN WATERS

Issues Regarding Waste Disposal in Open Ocean Waters

Waste disposal in the open ocean is generally limited to the dumping of acid or alkaline industrial wastes, sewage sludge, and dredged material. The permitting system established under the Marine Protection, Research, and Sanctuaries Act has been relatively successful in managing such dumping: dumping of industrial wastes has declined dramatically, and the dumping of sewage sludge and dredged material is relatively well-controlled.

Some of the wastes currently dumped in the open ocean also can be used beneficially on land and in certain aquatic settings. When relatively uncontaminated, for example, dredged material can be used for beach or wetland replenishment projects, and sewage sludge can be used as a fertilizer or soil conditioner on farms and forests.

Most often, however, these wastes must be managed by other treatment or disposal options, and pressure to use the open ocean for dumping will probably increase. In light of these pressures as well as the 1981 court decision (*City of New York* v. *United States Environmental Protection Agency*) that required the balanced consideration of all available alternatives, **a total ban on disposal in the open ocean seems unlikely.**

It is essential, therefore, to consider whether there are conditions under which open ocean disposal might be environmentally acceptable. Some wastes (e.g., sewage sludge, dredged material, and acid and alkaline wastes) probably can be dumped in the open ocean, if levels of toxic pollutants in the wastes are low, without causing significant long-term impacts. Open ocean features and processes (e.g., large volume, well-mixed waters, high dispersal ability) reduce the likelihood of impacts such as hypoxia, eutrophication, and significant accumulations of suspended material. In addition, the open ocean is generally capable of quickly neutralizing acid or alkaline wastes because of its large natural buffering capacity. Some pipeline discharges might be environmentally acceptable for the same reasons.

However, some uncertainty is associated with these conclusions. For example, it is unclear whether pathogens and toxic chemicals, at concentrations likely to exist at disposal sites, can cause long-term impacts on open ocean organisms and populations, or whether the overall productivity of the open ocean would be affected by such impacts.

Other factors could constrain open ocean disposal of relatively uncontaminated wastes. In particular, most pipelines probably could not be sufficiently extended into open ocean waters (particularly on the Gulf and east coasts, where the distance to the open ocean generally is greater than on the west

coast), and the shifting of dredged material dumping further out to sea may be seen as prohibitively costly in many cases.

In contrast, contaminated material can rarely if ever be used beneficially and therefore generally requires some form of disposal. In such cases, the full range of available options, including some forms of marine disposal, needs to be evaluated. Marine disposal that depends on containment rather than dispersion may sometimes be preferable to land disposal. For example, "capping" of some contaminated dredged material with clean material may cause fewer impacts than disposing the same material on land. Similarly, solidified coal ash potentially could be used in the construction of artificial reefs.

Options for Managing Waste Disposal in Open Ocean Waters

Two basic policy directions exist regarding waste disposal in the open ocean: maintain or strengthen the current restrictive policy, or allow increased disposal of some wastes under some conditions. Each choice involves some specific implications that are addressed by the options described below.

Option 1: Maintaining or Strengthening the Current Restrictive Policy

As currently implemented, MPRSA tends to restrict waste disposal in the open ocean. Maintaining or strengthening this policy could be justified, even though open ocean disposal is technically and economically feasible under certain conditions, because of concerns about the long-term health of the open ocean or because policymakers decide that allowing more ocean dumping might hinder the development of better management options. Thus Congress could strengthen this policy by amending the Act to specifically exclude particular wastes from eligibility for dumping, although total restriction of open ocean waste disposal appears implausible.

Choosing to maintain the current restricted policy, however, might preclude some measures for improving the health of estuaries and coastal waters (e.g., shifting disposal activities further out to sea). Therefore, ensuring the availability of alternative options, such as beneficial use or land-based treatment and disposal options for wastes that could be disposed of in marine waters, would be a critical component of continuing this policy.

Option 2: Allowing Increased Disposal of Some Wastes

A choice also could be made to allow increased disposal of some wastes in the open ocean under certain conditions because of the environmental acceptability of and increased pressure for some disposal. If some increase in open ocean disposal is allowed, many of the necessary statutory and regulatory mechanisms to ensure sufficient control are already in place.

Whether or not open ocean waste disposal increases, Congress probably would need to support and oversee several important aspects by:

- **Ensuring that disposal sites and methods are chosen so that impacts are minimized.** MPRSA criteria for choosing open ocean disposal sites appear to be sufficient if rigorously implemented by EPA. It might be worth considering whether the use of several carefully selected sites is preferable to the use of only one or two dumpsites for a particular waste. Using several sites would reduce the input of pollutants (and the possibility of subsequent impacts) at any one site, but it also would require additional resources for monitoring and surveillance.
- **Supporting efforts to reduce pollutants in wastes prior to disposal.** The options for reducing pollutant levels in estuaries and coastal waters are equally applicable to waste disposal in the open ocean; they include, for example, greater implementation and enforcement of the pretreatment and NPDES programs.
- **Providing additional resources for properly designed and nationally coordinated monitoring and research programs, and ensuring that results are used in future policy decisions.** Greater support and coordination of monitoring and research is needed to ensure that significant impacts (including those that might become evident only after several years) are detected and that information on these impacts is effectively analyzed and disseminated. In addition, Congress could consider developing an explicit policy that allowed disposal to continue only if monitoring detected no significant impacts ("significant" or "unacceptable" impacts probably should be carefully defined prior to disposal). This could include specific provisions requiring that the disposal activity be phased out or modified if such impacts were detected. MPRSA currently appears to provide sufficient authority to phase out harmful disposal activities, as witnessed by the reduction of industrial waste dumping.
- **Ensuring that open ocean disposal does not hinder the development and use of other options, such as land-based treatment or beneficial use.** Existing provisions, if implemented consistently and rigorously, appear to provide a means of addressing this issue; for example, regulations (under Secs. 101 and 102 of MPRSA) for granting ocean dumping permits require:
  —initial analysis of all management and disposal options,
  —demonstration of a *need* for open ocean disposal, and
  —periodic reconsideration of other available management and disposal alternatives.

  Congress also could consider influencing market conditions to attain specific goals. For example, financial incentives such as fees, taxes, or tradable discharge permits could be used to make the total cost of ocean dumping comparable to that of other options or to ensure that short-term economic factors alone do not drive decisions regarding dumping.

Related OTA Reports

- *Ocean Incineration: Its Role in Managing Hazardous Wastes.* OTA-O-313; August 1986.
- *Serious Reduction of Hazardous Waste for Pollution Prevention and Industrial Efficiency.* OTA-ITE-317; September 1986.
- *Transportation of Hazardous Materials.* OTA-SET-304; July 1986. GPO stock #052-003-01042-9; $13.00.
- *Superfund Strategy.* OTA-ITE-252; April 1985. GPO stock #052-003-00994-3; $10.00.
- *Protecting the Nation's Groundwater From Contamination.* OTA-O-233; October 1984. GPO stock #052-003-00966-8; $7.50.
- *Acid Rain and Transported Air Pollutants: Implications for Public Policy.* OTA-O-204; June 1984. GPO stock #052-003-00956-1; $9.50
- *Technologies and Management Strategies for Hazardous Waste Control.* OTA-M-196; March 1983. NTIS order #PB 83-189 241.

NOTE: Copies of the report "Wastes in Marine Environments" can be purchased from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402-9325, GPO stock No. 052-003-01062-3.

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